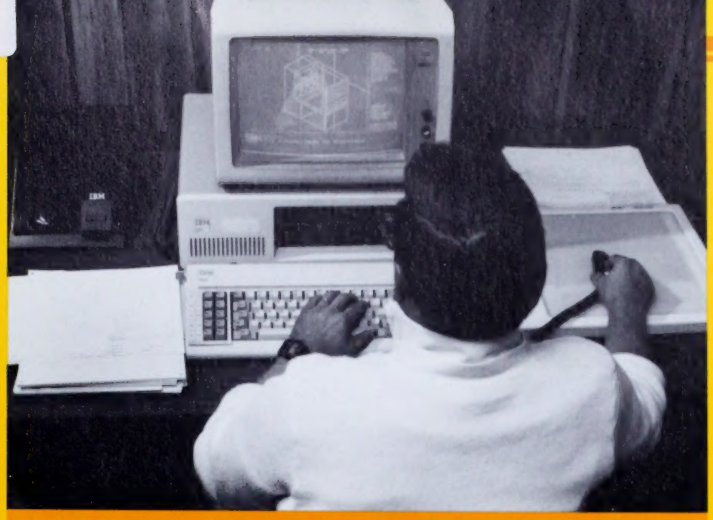


Energy Conservation and Renewable Energy Research, Development & Demonstration Program

Annual Review 1984/85

ALBERTA ENERGY AND NATURAL RESOURCES

Energy Conservation and Renewable Energy Research, Development & Demonstration Program

Annual Review 1984/85

Alberta
ENERGY AND
NATURAL RESOURCES
Scientific and Engineering
Services and Research Division

Contents

Director's Report Energy Conservation and Renewable Energy is one of the major priority areas of the overall Alberta/Canada Energy Resources Research Fund (A/CERRF) Program. Since the program began in 1976, energy conservation technologies have developed rapidly. This has caused A/CERRF's thrust to shift from encouragement of fundamental research to support for applied research, development and demonstration of these new technologies in order to promote their early and wide introduction and application in Alberta.

During fiscal year 1984/85, the program contributed a total of $880 295 to 27 active projects in three categories: General Energy Conservation, Energy Conservation in Buildings and Wind Energy.

Within the General Energy Conservation sub-program, Bow Valley Research Ltd., Calgary, is currently completing the last component of the successful ''Energy Conservation in Sour Gas Processing'' research project, which not only increased our knowledge of the subject but was also a commercial success for the company.

Twenty-three projects related to Energy Conservation in Buildings focused on such areas as novel construction techniques, space heating systems and energy conservation retrofit technologies. They also covered air leakage and measures for improvements, energy management and control systems/methods, and the development and demonstration of new products and materials.

Results to date include the successful retrofit of an Edmonton residential home, which features an energy conservation information and activity centre for the general public. In addition to A/CERRF contributions, the centre received substantial support from the City of Edmonton, the local commercial sector and from numerous volunteers. It was officially opened on February 28, 1985.

Preliminary monitoring results of retrofit demonstrations and infiltration tests in residential housing indicate that energy and cost savings are less than originally expected in some cases. However, studies have shown that masonry construction may be a viable alternative to conventional home building, and an Alberta furnace manufacturer has successfully developed a line of new mid-efficiency residential furnaces. Performance tests on new, high-efficiency furnaces confirm the manufacturer's specifications. The cost-effectiveness of these units, however, is questionable and remains to be proven. Sunergy Systems Ltd. of Carstairs, Alberta, successfully developed an insulating curtain for controlling heat losses or gains through glazed areas in buildings. The development of a number of energy management or control systems is progressing well, and Vinto Engineering Ltd. of Edmonton produced a comprehensive report on more than 100 computer programs suitable for building design or performance analysis. In addition, the company compiled an Alberta weather data package for use in related computer programs. The data are based on eight representative areas of the province.

Southern Alberta Institute of Technology in Calgary is making progress in the development of a training computer and course for building operators. Considerable interest in the project was expressed by building owners and operator organizations and other institutions in Canada and the United States, who are anxious to acquire the computer simulation system for their own training programs.

Because several additional topic areas are of further interest, the Energy Conservation in Buildings Subprogram has been extended into fiscal year 1985/86.

Within the Wind Energy Subprogram the first three-year demonstration and test period of small-scale wind turbines at Lethbridge was completed successfully under the leadership of the Drainage Branch of Alberta Agriculture. The project was particularly useful for wind turbine manufacturers/distributors and potential farm users. In response to the continuing need, another three-year test period has been approved.

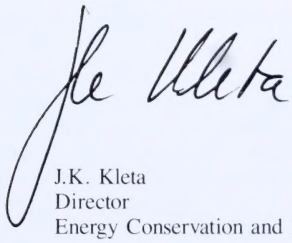
Equally impressive is the further development of delta-blade wind turbine technology by Deltx Windpump Corporation of Calgary. Two new models have been designed. The 16-metre diameter prototype turbine, erected on the plant site of Abax Energy Services Ltd. west of the Calgary International Airport, was tested and improved and commercialization of the technology has been vigorously pursued with promising results.

Alberta Research Council continued its well-received services through the Solar and Wind Energy Research Program (SWERP) Information Centre and Data Base and completed the solar and wind

energy monitoring program. Although the data from monitoring are yet to be fully analyzed and documented they should be useful for engineers, designers and other interested groups involved in the application of renewable energy technologies.

In addition to these subprogram areas and in recognition of the considerable potential for energy conservation in industry and the commercial sector, a new subprogram on Waste Heat Recovery/Low Temperature Heat Utilization Research, Development and Demonstrations has been developed in close co-operation with representatives from industry, academia and governments. The new program was advertised in all major Alberta newspapers during March 1985. The subsequent response will lead to implementation of selected and approved projects by late 1985.

In summary, the Energy Conservation and Renewable Energy Research, Development and Demonstration Program, a subprogram of the Alberta/Canada Energy Resources Research Fund (A/CERRF) Program, is progressing well, thanks to the concerted effort and support of the private sector, academia and governments. It continues to produce interesting results, it enhances expertise and know-how in the technology area and it promotes and initiates commercial opportunities in Alberta.



J.K. Kleta
Director
Energy Conservation and Renewable Energy Research

Introduction This review covers the activities of the Energy Conservation and Renewable Energy Program during fiscal year 1984/85.

The program focuses on a number of specific areas:

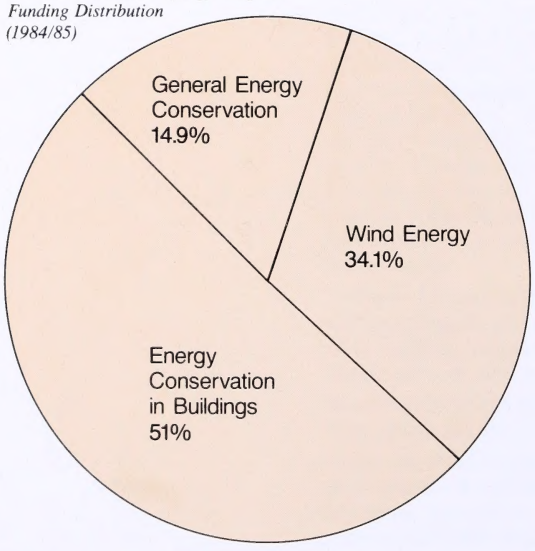
—general energy conservation
—energy conservation in buildings
—wind energy

Funding for the program is provided through the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces. The federal government pledged increased funds to strengthen and diversify Alberta's economy, including $96 million for energy-related research projects. Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

Building on the work of previous years, the program in 1984/85 continued with its research, development and demonstration projects. Emphasis was given to demonstrating the technical feasibility of new technologies in both energy conservation and alternative energy, and to identifying their economic potential in Alberta.

The following section, Review of Program Projects — 1984/85, provides detailed information of progress achieved in individual projects.

Fig. 1: A/CERRF Energy Conservation and Renewable Energy Program Funding Distribution (1984/85)



A breakdown of program expenditures of approximately $880 295 for general energy conservation, energy conservation in buildings and wind energy is shown in Fig. 1—A/CERRF—Energy Conservation and Renewable Energy Program Funding Distribution (1984/85). A new focus area for the program—waste heat recovery—was being developed during the year and it is expected that specific projects will begin in fiscal year 1985/86.

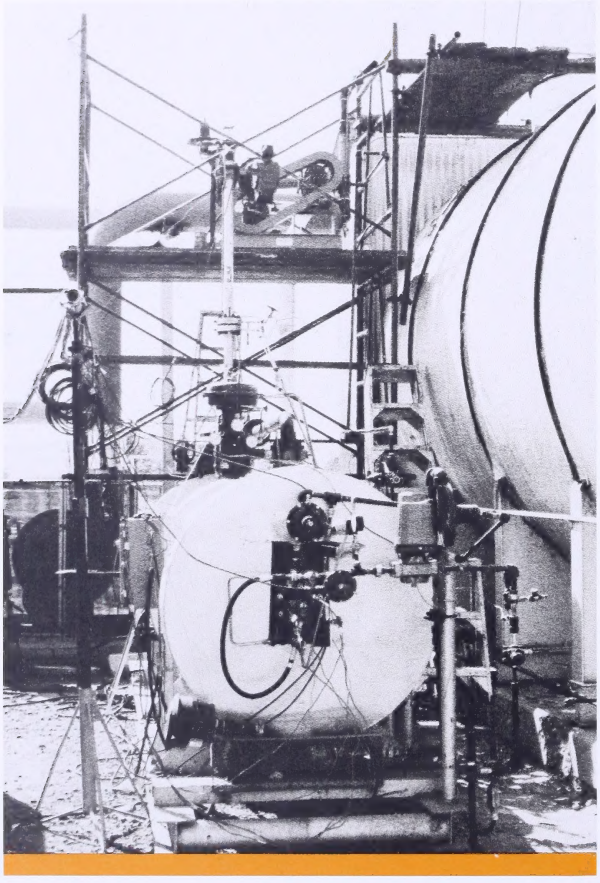
Approved research projects and related expenditures are listed in Appendix A: A/CERRF—Energy Conservation and Renewable Energy Projects and Expenditures to Date.

	Funding ($)	Percentage (%)
General Energy Conservation	131 399	14.9
Energy Conservation in Buildings	448 475	51.0
Wind Energy	299 881	34.1
Adjustment to previously funded Research Project	540	
TOTAL	**880 295**	**100.0**

Review of Program Projects 1984/85

General Energy Conservation

A pilot scale catalytic/recuperative incinerator installed at an Alberta sour gas plant.



Energy Conservation in Sour Gas Processing

—Bow Valley Research Ltd., Calgary Much of Alberta's natural gas is said to be "sour" because it contains hydrogen sulfide and other undesirable components which must be removed before the gas can be used as a fuel or industrial feedstock. Removal of these substances is done in gas processing plants that consume considerable quantities of energy.

During an eight year project period, Bow Valley Research Ltd. successfully developed improved technology for reducing energy consumption in natural gas processing plants, including advanced Claus Process, control and waste gas incineration systems. The company not only became world renowned experts in Claus Process technology but also successfully marketed related control instrumentation and waste gas incinerators on a multi-million-dollar scale. During 1984/85, the company completed field tests and experimental work on the following two additional developments: Catalytic/Recuperative Incineration, and Energy Audit and Energy Conservation Strategy for Natural Gas Processing Plants.

Results indicate that advanced catalytic/recuperative incinerators will further reduce energy consumption in waste gas incineration in sulphur plants, which process waste gas streams with high fuel concentrations.

The developed energy audit and strategy for natural gas processing plants is of a cyclic nature. Usually, the first step identifies the overall energy distribution and usage in the plant and during subsequent cycles non-specific decreasing amounts of energy consumption are analysed until all significant consumption is identified and documented. Audit strategy results provide a tool for implementing energy conservation measures in Alberta natural gas plants, with potential power savings of 750 MW, comparable to the capacity of the Wabamun generating plant.

Detailed technical information about this research effort may be obtained from the contractor.

Energy Conservation in Buildings

Edmonton's Energy Conservation Centre is an ideal place to learn about energy saving ideas.

Edmonton Energy Conservation Centre—Tomorrow Foundation, Edmonton A facility dedicated to providing information on residential energy conservation measures is now open to the public. The Edmonton Energy Conservation Centre (or E2C2), an old house which has been extensively retrofitted using a wide variety of energy conservation measures, is located at 10511 Saskatchewan Drive. The Centre's primary functions are to demonstrate energy-efficient retrofit measures and to promote residential energy conservation. Although E2C2 is operated by the Tomorrow Foundation it is controlled by a management board.

Prior to renovations, the city-owned, two-storey brick house dating from about 1911 was in need of general repair and had very high heating bills. In a cooperative effort, the city provided the house, Alberta Department of Housing funded a retrofit design and remodelling work was supported by A/CERRF, the Federal Government (Canada Works and Katimavik) and numerous businesses and individuals.

Major renovation and retrofit measures included lowering the basement floor, repouring the basement, replacing all floor joists, upgrading the insulation, sealing the outer structure against air leakage, and replacing the heating system with a high-efficiency furnace and an air-to-air heat exchanger. The effectiveness of these measures was borne out by a marked reduction in heating bills.

The Centre commenced operations with an official opening on February 28, 1985. The program for the first year of operation includes development of visual displays and a library (possibly including video tapes), courses and workshops, technical monitoring of energy conservation and performance, and monitoring the extent of public interest.

Energy Savings and Payback of Retrofit Basement Wall Insulations—Dow Chemical Inc., Edmonton/Toronto Heat losses from uninsulated basements in residental homes account for a large portion of annual heating costs. Using various insulation materials, such as extruded (SM) and expanded polystyrene (bead board), rigid (Glass Clad) and batt glass fibre insulations, this demonstration project aims to determine the most cost-efficient retrofit option for Alberta homeowners. SM insulation was placed on the outside basement walls down to the footing of one residential home and Glass Clad was used on another. In addition, a third home received bead board insulation on the inside basement walls, while fibre batt insulation was used on a fourth house. A fifth house has been identified for a bead board insulation application on the outside basement walls.

Costs for the installations, which were done by contractors, range from $4 200 to $4 600 for exterior retrofits and $3 200 to $3 500 for interior retrofits. Utility bills providing information on energy consumption in these homes are being collected and evaluated. Meanwhile, at Ellerslie, direct heat loss through basement walls of unoccupied housing modules is being monitored at the Alberta Home Heating Research Facility of the University of Alberta. The measurements clearly indicate that heat loss reduction of about 60% can be achieved for R10 externally-insulated basement walls versus uninsulated walls. Final results will be made available in fiscal year 1985/86.

Retrofit Wall Systems for Residential Housing—Alternative & Retrofit Energies Ltd., Calgary One of the better approaches when upgrading older houses that suffer from poor air sealing and wall insulation is to add a ''piggy-back'' insulating wall on the exterior of the building. A detailed survey of existing retrofit wall systems has been carried out, and arrangements are being finalized to demonstrate two of the most promising ones.

Townhouse Retrofit Demonstration—Love Energy Consultants, Calgary Townhouses constitute 12% of the existing housing stock in Calgary and it is expected that their proportion in future residential construction will increase because of the trend toward greater housing density. Previous studies indicated that occupants of townhouses were uncomfortable with temperature differences between upper and lower storeys and they were unhappy with deficiencies in construction. In order to develop a better understanding of the thermal performance of townhouses and potential retrofit measures, tests were conducted over the 1983/84 and 1984/85 heating seasons with two different pairs of townhouses. The units were left unoccupied to eliminate any overriding effects caused by occupancy. Tests and retrofit measures included air leakage and thermography measurements, basic air-sealing of the units, basement insulation, isolation of furnace rooms and monitoring of their effects on energy efficiency and performance. Preliminary test results indicate varying degrees of quality in the construction of these townhouses. In addition, the retrofit measures were not always applicable and seemed to provide lower than expected improvements in energy efficiency. An average 10% improvement in energy efficiency seems to be achievable. The test data are being further processed and analysed. When accurate results are available, the specialists may want to review in greater detail the overall question of energy conservation-related retrofit measures, expected improvement in the energy efficiency of townhouse units, and the associated cost effectiveness of these measures. New approaches and methods may be required, particularly in view of potential overriding effects of occupants' behaviour on energy consumption in residential housing, which could be substantially higher than savings through simple retrofit measures. A detailed technical report is being prepared.

Depressurization fans inserted in door openings were used to measure the air-tightness of unoccupied townhouses.

Self-Help Retrofit Manual for Owners of Multi-Family Housing Units—Alternative & Retrofit Energies Ltd., Calgary When owners and operators of housing co-operatives, condominiums, row housing, townhouses, public housing and other forms of multi-family housing attempt to retrofit their buildings for energy conservation, they face a bewildering array of options and claims. Alternative & Retrofit Energies Ltd. is preparing a step-by-step guide to assist such people in evaluating and selecting appropriate retrofit measures for their facilities. The guide will be based upon ongoing research involving a wide range of retrofit equipment and techniques. Tests are being conducted in various multi-family housing units to analyse heat loss and to determine the effectiveness of retrofit measures.

Energy-Efficient Housing Display Program—Housing and Urban Development Association of Canada (HUDAC), Alberta Chapter, Edmonton Through the co-operation of HUDAC and builders in Edmonton and Calgary, five energy-efficient homes were constructed in each city to demonstrate energy conservation conservation features. All the houses were open to the public for six weeks as part of the 1981 HUDAC Parade of Homes in both cities. They were subsequently sold and occupied, and permission was obtained from owners to install monitoring equipment and to access it periodically. The energy consumption and conservation performance of the houses was monitored for two heating seasons, and the results are being evaluated.

A Survey of Air Leakage in Alberta Homes—Bill Johnston Architect Ltd., Calgary Air leakage rates were measured in 117 owner-occupied dwellings, covering a cross section of various construction types, dwelling age and other characteristics such as types of siding material. The test sample indicated that on average one-third of a dwelling's air volume is exchanged in one hour. Following these initial leakage measurements, 31 homes were weatherstripped and sealed either by the homeowners themselves or, in 21 cases, by professional tradesmen. The effectiveness of these sealing retrofits were then tested.

While all the measurements are yet to be analysed in detail, the data suggest that the retrofits performed by both groups were similarly effective. Reductions of about 26% were achieved for the air exchange rate. Because air leakage is directly related to heat losses, this reduction in the air exchange rate indicates a potential decrease of approximately 10% in the required energy consumption for the average single-family home through home sealing retrofit measures. Ongoing monitoring of energy consumption in these sealed homes is aimed at verifying the estimated reduction. In addition, the most promising areas and effective techniques for sealing homes against uncontrolled air leakage will be identified for the benefit of home owners as well as contractors. The study will also increase the existing data base on air leakage quality of home construction in Alberta and provide information comparable to studies performed in other provinces.

A test home using a double wythe masonry wall consumed only 78 per cent of the energy used by an equivalent wood construction home.

Construction and Testing of a Masonry Module—Alberta Masonry Institute, Edmonton, and I-XL Industries Ltd., Edmonton/Medicine Hat An estimated 20% of all energy consumed in Canada goes into residential space heating. Much effort has been directed toward new technology and methods which show potential for significant reductions. The use of different building materials and construction techniques could be an alternative to conventional home construction and they might lower heating energy requirements. Masonry construction technology is being recommended by its proponents as such an alternative. In order to demonstrate the concept, a double wythe wall masonry housing module was constructed at the Alberta Home Heating Research Facility of the University of Alberta in 1983 to compare it with a standard wood construction module. Each unit is the size of a double garage and has a full basement. They are unoccupied and are heated electrically under well-controlled conditions.

The main test criteria are energy efficiency, heating energy consumption, air leakage or infiltration rates and thermal behaviour in changing weather conditions.

Test results to date indicate that the masonry module requires only 78% of the heating energy of an equivalent wood frame unit. Part of this energy reduction is due to a lower air infiltration rate (approximately 60% of the conventional wood construction module). Using the measured air infiltration rate of 0.2 air exchanges per hour, the HOTCAN computer program predicts the relative energy consumption for the masonry module should be 12% less than the standard unit.

Overheating during summer months is also considerably less apparent for the masonry module and may occur for short periods in the high summer season of July and August. This is due to its considerably greater heat capacity and a corresponding time constant of approximately 7 hours, which tends to even out heating requirements and indoor temperature during the day.

Without considering the fact that masonry homes may be more expensive, the above results show a distinct improvement in the thermal performance of a masonry house over conventional wood frame construction. A final project report, which is expected by the fall of 1985, will include an economic comparison of the two technologies together with more detailed monitoring results. In addition, the project raises a number of interesting topics worthy of further investigation, such as: the heat transfer mechanisms that apply to complex wall systems, methods of accurately determining insulation values and the heat capacity of various construction materials.

Concrete Masonry Walls for Thermal Storage, Heating and Insulation—Centre for Research and Development in Masonry, Calgary Residential buildings in Alberta are mainly of wood frame construction. Relatively little is known regarding the potential of alternative construction techniques and materials to conserve energy. Therefore, the objective of this project was to evaluate and optimize alternative uses for concrete masonry walls and floors in residential construction.

Due to economic constraints the project contractor was not able to continue the planned program beyond an initial and thorough review of state-of-the-art masonry components in residential buildings entitled "Thermal Properties of Masonry Elements and Buildings."

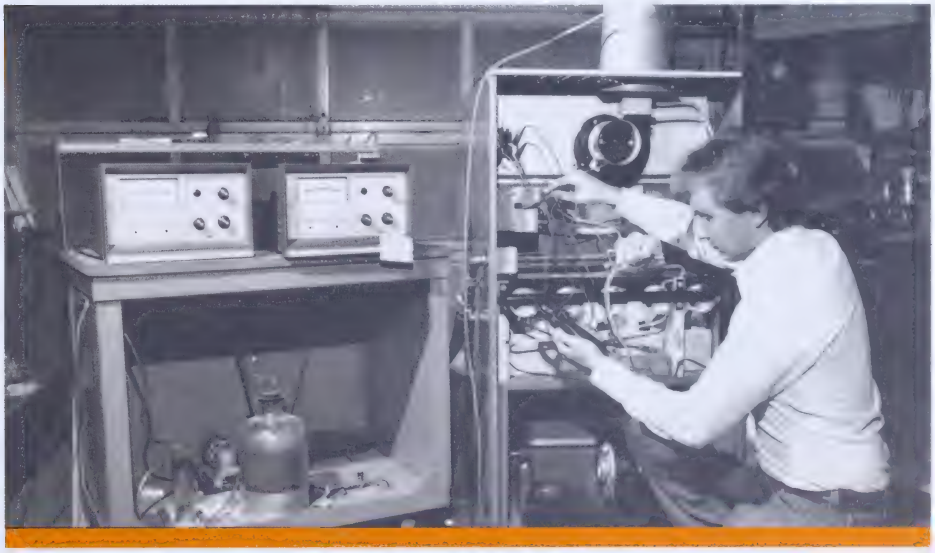
Sizing of Warm Air Furnaces for Residential Use—J.E. Sworder Engineering Ltd., Edmonton Modern construction techniques have resulted in major reductions of heat loss from residential homes, and furnace manufacturers have done their part by developing higher-efficiency home heating equipment. This study reviewed and analyzed the conditions and requirements for selecting adequately sized furnaces for new and energy-efficient residential housing units. The study concluded that heating loads, furnace operation cycles and required air circulation rates are the main criteria to be considered in determining the proper size of furnace for residential housing units, particularly for energy-efficient homes.

Development of Higher-Efficiency Gas-Fired Furnaces—Flame-Master, Division of Bow Valley Industries, Edmonton Following a detailed market study, Flame-Master, an Edmonton furnace manufacturer, decided new lines of higher-efficiency gas-fired furnaces and suspended unit heaters should be developed, tested and introduced into western Canadian and U.S. market.

During fiscal year 1984/85 the company concentrated on the design, testing and prototype production of mid-efficiency, non-condensing, forced air, gas furnaces (HFM models). The effort succeeded in a prototype production run of the HFM models, their temporary CGA certification and their successful testing in the field. While most other furnace performance characteristics are based on low-altitude area tests, Flame-Master measured and operated its furnaces under realistic local conditions, i.e. in Alberta's high altitude areas and during cold winter months. An effective seasonal efficiency of 80% was identified for the HFM models, compared to 55% to 60% for standard forced air gas furnaces.

The company plans to market this new line of furnaces in Western Canada during 1985, and plans to extend its distribution to eastern Canada and the U.S eventually.

Progress was also made in the design and shop testing of suspended unit heaters featuring sealed combustion and a power vented exhaust. This new product line requires further development, which is planned for the 1985/86 fiscal year. The company will also continue with initial work on high-efficiency furnaces and unit heaters.



The efficiency of natural gas furnaces was measured at the Alberta Home Heating Research Facility operated by the University of Alberta.

Seasonal Efficiency of Residential Natural Gas Furnaces—University of Alberta, Edmonton

Natural gas furnace manufacturers have developed a variety of high-efficiency units in a general effort to reduce energy consumption in residential housing. This project's objective is to independently and reliably measure the seasonal efficiency of representative products now on the market. Four of six test furnaces were purchased and installed in two of the housing modules of the Alberta Home Heating Research Facility of the University of Alberta. During the 1983/84 and 1984/85 heating seasons, tests were conducted on an ICG Standard Unit, an ICG Conserver equipped with electronic ignition and a flue damper, an ICG Ultimate and a Lennox Pulse Unit. The ICG Ultimate and Lennox Pulse units are high-efficiency, condensing furnaces.

The efficiency of each furnace was determined by comparison with electric heating requirements and historical ratios for a reference housing module at the test site and by applying the testing procedure proposed by the Canadian Gas Association. The measured seasonal efficiencies were 71%, 77%, 96% and 94% for the ICG Standard, ICG Conserver, ICG Ultimate and Lennox Pulse unit, respectively. These values, which relate to the actual heating seasons only and do not include any potential summer standby losses, are in general agreement with claims by the manufacturers. The ICG Standard unit performs better than anticipated.

Tests showed a new, mid-efficiency gas-fired furnace was at least 20 per cent more efficient than standard forced air models.

Additional tests will be carried out during the 1985/86 heating season on the remaining two test furnaces. These are an AIRCO induced draft unit with electronic ignition and a motorized flue damper, and an externally installed AMANA unit which heats a water-glycol mixture and circulates it to the appropriate components inside the housing module.

Interesting for manufacturers and consumers alike is an initial estimate of a simple payback period of 10 years for high-efficiency furnaces. This is based on the measured seasonal efficiences, the incremental costs (November 1984) above the standard unit and an average heating bill of $600 per year for an Alberta home.

Final results and conclusions, expected by the end of fiscal year 1985/86, will be of interest to all groups concerned about residential space heating technology and its potential for energy conservation.

Energy Conservation in Public Swimming Pools—IBI Group, Calgary

Because indoor swimming pools are major energy consumers, they offer considerable potential for energy conservation measures and cost savings. In this context, twelve City of Calgary public pools were reviewed and analysed regarding building characteristics and operational practices. A representative pool was selected and a detailed evaluation of energy conserving measures was carried out. A number of low cost or no cost retrofit measures were identified, as well as a comprehensive retrofit strategy, including changes to the building skin.

The work to date confirms that significant energy savings are available and are cost-effective. The best potential seems to be in the operation of the facility and its mechanical systems. A major concern and challenge is the effective control of the obviously high humidity level in swimming pools. Upon approval by the City of Calgary, the energy conservation strategy will be tested and demonstrated in a representative pool.

Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology—EMC Energy Management Consultants Ltd., Calgary With the advent of energy-efficient construction methods that increase air-tightness, controlled ventilation and air-to-air heat exchange equipment becomes increasingly necessary. Using heat pipe technology, which has efficient heat transfer characteristics and was originally developed for space applications, EMC Energy Management Consultants Ltd. designed, built and tested two prototype air-to-air heat exchangers with favourable results. Heat pipe technology allows construction of compact and light weight units. Other than the usual fans, no moving parts are required. Installation is simple, and the unit requires little maintenance and can be easily cleaned. The company included novel design features to improve the economics of the heat exchanger, which offers multiple benefits of controlled ventilation, humidity control, summer cooling and frost protection. Development is continuing and a third prototype unit will be built for performance testing by an independent agency. Unit costs are estimated to be competitive with existing air-to-air heat exchangers.

Development of an Insulating Curtain for Residential Installation—Sunergy Systems Ltd., Carstairs Today's housing stock is being designed and built with an increasing commitment to energy conservation. Insulation levels in walls and ceilings are rising and have reached R40 to R60 values. Increasingly, there is a trend toward larger glazed areas in homes, particularly in connection with passive solar applications. The obvious discrepancy between the very low thermal resistance of glazed areas and well-insulated walls and ceilings has initiated a flurry of research and development activities aimed at upgraded energy performance of these glazed areas. The objective of this project is to develop an insulating curtain for residential application which is able to control heat loss or gain through glazing areas and thereby offer enhanced comfort as well as energy cost savings.

An Alberta-designed insulating curtain keeps indoor warmth from escaping through windows and can prevent overheating from sunshine during summer months.

An indoor insulating curtain can conform to the shape of roof-mounted windows.

During the past year the contractor designed and developed an insulating curtain, which prevents overheating of homes and avoids excessive heat loss through glazing.

A thorough investigation of several edge sealing techniques was undertaken and the most suitable has been utilized. Major hardware components were developed by the contractor and are now being fabricated in-house. Users of these insulating curtains have a choice of a broad range of decorative interior fabrics, and the curtain system is readily adaptable to all possible angles and slopes of glazed areas. The system can be very quickly installed in a variety of configurations and may be easily motorized with automatic controls. Test data show the product is reliable and durable.

A detailed final report is being prepared and the unique curtain system is being offered to a growing market.

Development of a User-Friendly Computerized Building Management System—MLW Interspace Management Ltd., Edmonton An easy-to-use and inexpensive Building Energy Management System was developed and a prototype unit was produced. The system, based on readily available microprocessor technology, consists of a remote programmable controller and a control and monitoring station. The components can be interconnected by cable within a building or remotely over telephone lines.

The modular concept allows monitoring and control of a large number of buildings by one remote control centre or the interconnection of up to ninety-nine remote programmable controllers for very large applications. Additional features include the possibility of direct digital control, i.e. direct communication between the control centre and control elements, and the total integration of digital and analog control functions.

A prototype system will be field tested in Edmonton during 1985/86 to demonstrate its performance, cost-effectiveness and potential for wide application in small and large buildings and facilities.

Multi-Zone Setback Thermostat—Daxcom Electronics Inc., Calgary A new and different approach toward energy management within large buildings has been pursued by Daxcom Electronics Incorporated. The company developed an electronic thermostat/controller capable of controlling 16 independent heating or ventilation zones in an individual building or in building complexes. Two prototype units have been successfully produced and shop tested. A marketing study, performed by the University of Calgary Business Action Research Group, indicates that a market exists for the product in buildings where pneumatically controlled ventilation and air conditioning systems have not been automated. Subsequently, the controller was modified and now it can be used for multi-zone temperature, ventilation and air conditioning control, as well as for controlling multiple roof-top heating units in commercial and industrial building complexes. The control unit has yet to be demonstrated in the field.

A New Heat-Conserving Control System for Warehouse-Type Buildings — Camcon Controls Ltd., Calgary To avoid excessive heat loss through open overhead doors of warehouses, a new electronic control unit has been developed, which shuts down suspended unit heaters within these facilities when their large overhead doors are opened. Additional features include an automatic temperature setback during unoccupied hours and the control of make-up air units in these facilities. Seven prototype controllers were installed in Calgary warehouses and their performance is being monitored. Preliminary test results show considerable savings of gas consumption in four warehouses. Three installations, however, showed little or no savings. Testing and investigation of specific system characteristics and conditions is continuing. Subject to conclusive and positive results, the company intends to manufacture these new units in Alberta for local, Canadian and export markets.

Demonstration of a Cost-Effective Energy Management System—Whitaco Holdings Ltd., Edmonton A low cost energy management system has been demonstrated in an Edmonton office and warehouse structure. The microprocessor-based unit controlled the on/off time and energy consumption by the building's nine unit heaters and one roof-top unit. In comparison with previous years, the monitored data indicate a savings of 21% in fuel consumption. Application of the energy management system in small- to medium-sized commercial buildings promises an appreciable reduction in operating costs. The project is being completed and detailed information on the energy management system—its performance and economics, as well as accurate test results—will be made available in a final project report.

Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta—Vinto Engineering Ltd., Edmonton Approximately 70 computer programs can be used by designers of buildings or building subsystems such as mechanical, electrical and heating, ventilation and air conditioning, insulation, lighting, piping and solar systems. Energy analysts may also choose from more than 40 programs for assessing and/or predicting the efficiency of buildings and building components.

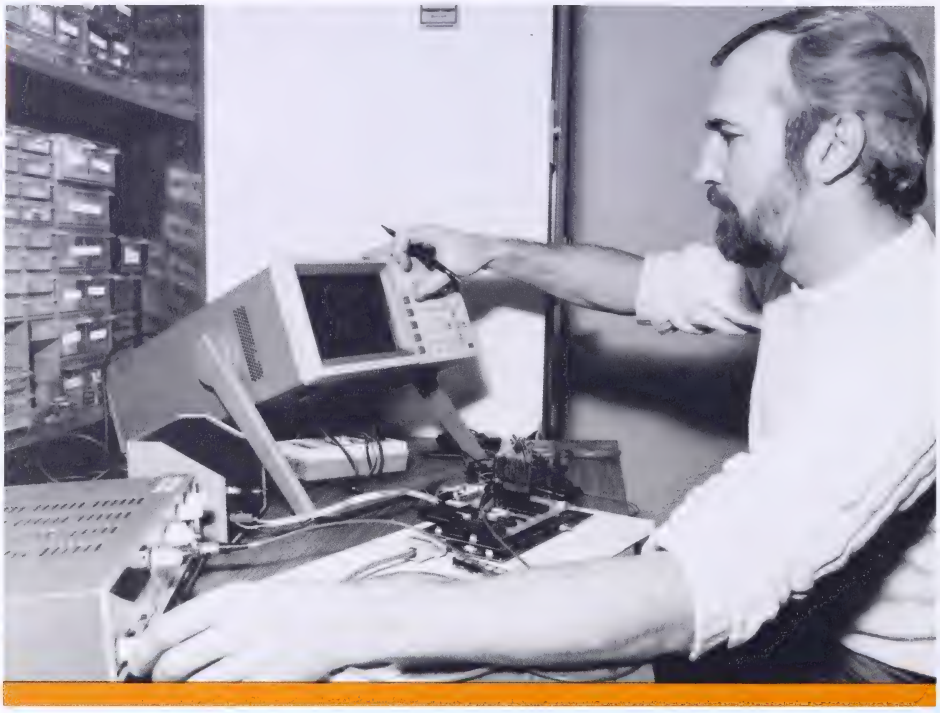
In order to assist potential users such as consultants, designers, builders and contractors in the selection of relevant and useful computer programs, Vinto Engineering Ltd. of Edmonton compiled information on all these programs and produced a comprehensive report. It identifies the usefulness of the programs for specific tasks or areas, their source, availability and accessibility, as well as the required computer equipment and related technical requirements such as program language, input/output characteristics and typical costs.

Many of these programs, in particular the energy analysis programs, require an input of climatic data in one form or another to predict the efficiency or energy consumption of a related structure or building at a defined location. The company, therefore, developed an Alberta weather data base which provides the required data from eight typical climatic regions of the province.

The data base has been compiled in a format directly applicable to two sophisticated energy analysis computer programs, the APES ESP-II and Meriwether ESA programs. A reduced format is also available that can be used in less complex energy analysis programs, such as the National Research Council's HOTCAN or the Carrier OPCOST programs.

Both the program inventory and weather data base reports have been completed and copies are available from Vinto Engineering Ltd. at a cost of $25 each.

A researcher at Southern Alberta Institute of Technology tests the electronic heart of a computer system meant to simulate mechanical systems in buildings.



Computer Simulations for Mechanical Systems in Buildings—Southern Alberta Institute of Technology, Calgary Considerable advances have already been achieved in developing and implementing technological hardware such as new construction techniques as well as more energy-efficient equipment and subsystems for buildings. Equally important is the need to understand these systems and how they operate. In response to the need for better training of building operators, Southern Alberta Institute of Technology (SAIT) pursued the development of a specific training course and a computerized simulation system.

Students will be able to simulate typical and basic heating, ventilation and air conditioning systems on a specifically-designed microcomputer. Two prototype computers have been completed as well as most of the required software and simulation programs. The low cost system is compact and portable.

A simplified keyboard with 8 color-coded keys enables any student with or without computer experience to operate and run simulations using either a standard color television or a computer monitor to display the simulation graphics.

Additional features will include options for other input/output and remote control equipment, a built-in real-time clock, a battery back-up and possibly a speech synthesizer. The complete system will have the flexibility to be used both as a valuable training tool and an energy management control system.

While the contractor experienced a number of problems in acquiring components of acceptable quality, particularly double-sided printed circuit boards, it is expected that the computer development can be completed by the end of 1985.

The project has been encouraged and well-received by the Building Owners and Managers Institute International, the local Building Owners and Managers Association and other training institutions and centres throughout Canada and the United States which are now interested in buying the computer and building simulation packages for their own programs.

A Ventilation Control System Based on Carbon Dioxide Levels—Cheriton Engineering Ltd., Calgary The application of available carbon dioxide sensing and control technology in buildings with conventional mechanical ventilation systems is expected to offer savings in energy consumption and operating costs. The preparatory work toward a demonstration of the technology, performed by Cheriton Engineering Ltd. of Calgary, revealed, however, that its economic potential is somewhat limited. The carbon dioxide control system seems to be incompatible with heating, ventilation and air conditioning systems, which include induction subsystems for particular building zones or utilize free cooling to a large extent. This is the case for the originally proposed J.J. Bowlen Building in Calgary. Because a more suitable building could not be identified within a reasonable time frame, this project was abandoned for the time being.

E nergy-Efficient Fluorescent Lighting Ballast — Comtrac Industries Ltd., Airdrie An attempt by Comtrac Industries Ltd. to develop a cost-effective and energy-efficient electronic fluorescent lighting ballast has failed. The required high voltage electronic components for switching power supplies are not yet available for such an electronic ballast, which would allow high frequency operation of fluorescent tubes, thus increasing their luminous output while reducing power consumption in the order of 30%. However, bearing in mind the fast development and advancement of today's electronic technology, the contractor suggests that the availability of the required components—with the realization of cost-effective and energy-efficient electronic ballasts—will be only a matter of time.

E xtension of the Energy Conservation in Buildings R,D&D Subprogram Research projects related to Energy Conservation in Buildings have been focusing on a number of specific areas, including novel construction techniques for residential housing, related heating systems and energy conservation retrofit technologies. Also, air leakage studies and measures for improvements, residential energy conservation retrofit demonstrations, energy management and control systems and methods, and the development and demonstration of new products and materials have been performed.

Assisted by the Energy Conservation Branch of Alberta Energy and Natural Resources, a review of these projects and results by the A/CERRF Committee identified additional areas of interest and relevance.

It seems that further work is warranted on retrofit demonstrations in commercial, industrial, institutional or highrise buildings, focusing on energy control systems, lighting systems and the control and reduction of air infiltration in larger buildings.

Also, additional investigation of the following is warranted: applied high-efficiency furnaces, use and control of adequate space heating systems, ventilation control and heat recovery in commercial buildings, and demonstrations of new products and materials in related facilities.

An extension of the Energy Conservation in Buildings R,D&D Subprogram has subsequently been approved for implementation during 1985.

Wind Energy

Demonstration and Testing of Small-Scale Wind Turbines—Alberta Agriculture, Lethbridge Under the leadership of the Drainage Branch of Alberta Agriculture and with funding from A/CERRF and Alberta Agriculture, a test site was established at Lethbridge during 1982. Six small-scale, water-pumping wind turbines were subsequently installed and monitored for three years. Demonstration and testing of these turbines is particularly focused on performance characteristics of the units under varying wind conditions, their water pumping rates, survivability, maintenance requirements and frequency of breakdowns. While the monitoring data and results indicate that the wind turbines generally performed in agreement with the manufacturers' specifications, these tests under actual field conditions helped to identify weak points and potential improvements, thus allowing manufacturers to increase the efficiency and performance of their units through minor and simple modifications.

Preliminary conclusions from the three-year test period indicate that small-scale wind turbines offer a practical and economic power source for pumping water at locations where electric power is not readily available.

The performance characteristics of six water pumping wind turbines were monitored at a test site in Lethbridge.

Further performance test data are essential to evaluate the suitability of a given wind turbine at a specific site with its characteristic wind regime.

The project received considerable attention from many individuals and interest groups, including local farmers, wind turbine manufacturers and distributors, as well as representatives from industry and governments in Alberta, Canada, the United States and Europe. Numerous tours were organized each summer and special demonstration days attracted 200 to 300 visitors. The project has been particularly useful for participating wind turbine manufacturers and distributors and potential users of these units within the agricultural community. All project data and results to date are being analysed and will be documented in a detailed final report. Based on the success of, and the continuing need for, field demonstrations and performance testing of these and new small-scale water-pumping wind turbines, the project is being extended for another three-year period.

Solar and Wind Energy Research Program (SWERP)— Alberta Research Council, Edmonton The last full year of routine field measurements of solar and wind energy data has been completed at seven monitoring stations in strategic and representative locations of Alberta. The SWERP group within Alberta Research Council reviewed measurements made during 1984/85 as well as in previous years to prepare a final analysis and to document the data. It is believed this information will be very useful for all interested individuals and groups, including designers, planners and others involved in the application of renewable energy.

The Alberta Research Council also continued to provide its information services to Alberta's industry, academia, government and the general public through its SWERP Information Centre and Data Base. Its staff responded to over 1 200 specific enquiries during the fiscal year and the centre remained a focal point for online computer access to information on energy conservation and renewable energy technology.

In order to provide such services to all Canadians and to avoid duplication, it was decided that instead of updating the original SWERP data base, staff would continue developing the new Canadian renewable energy data base ENERCAN in cooperation with the Canada Institute for Scientific and Technical Information (CISTI) of the National Research Council, using the standard international format for technical data bases. Besides the provision of a useful service to Canadians, this national data base seems to be a prerequisite for future exchanges of related information on an international basis.

Large Delta-Blade Wind Turbine, an Alberta Development — Abax Energy Services Ltd./Deltx Windpump Corporation, Calgary

The prototype, 16-meter-diameter Delta-blade Wind Turbine, erected on the plant site of Abax Energy Services Ltd., west of the Calgary International Airport near the Deerfoot Trail, has become a Calgary landmark. Based on a design by Professor J.A.C. Kentfield of the University of Calgary, the turbine was initially developed by Abax Energy Services Ltd. and, since the beginning of 1984, by the newly-formed Deltx Windpump Corporation, both of Calgary, with significant funding by A/CERRF.

Large delta-blade wind turbines, designed and built in Alberta, may be used effectively in irrigation schemes or for other direct water pumping applications.

With substantial private sector participation and investment, Deltx initiated a variety of activities over the past year and began to implement an ambitious development plan. Based on the original concept, a new, smaller delta blade wind turbine has been designed and several prototypes of these Windpump 20 units have been fabricated. In addition, a new slightly larger wind turbine, Windpump 65, has been designed for large-scale irrigation and hydro storage/hydro power applications.

A shop test rig was built at the Abax site to test turbine and water pump components. With additional funding from A/CERRF and the National Research Council the 16-metre-diameter prototype turbine, Windpump 50, was operated and monitored during the second half of the 1984/85 fiscal year. Test results, however, were not fully conclusive due to leaks in the water pumps, which developed during the monitoring period.

The tests also indicated that the response of the mechanism which controls the stroke of the water pumps in relation to the wind speed and turbine output, was not optimal. Deltx, therefore, made further improvements to the prototype turbine and developed a new control approach. Additional and detailed performance tests are planned for the next fiscal year.

Besides these technical tests and developments, the company also vigorously pursued sales for delta-blade wind turbine technology. Potential field demonstrations and large-scale applications include water pumping in irrigation systems, the establishment of suitable marshes and habitat for water fowl, and pumped storage for hydro power systems. This promising technology has attracted considerable interest both in Canada and abroad.

Waste Heat Recovery

Waste Heat Recovery/Low Temperature Heat Utilization—Research, Development and Demonstration Subprogram Rising energy costs since the energy crisis in the early 1970s caused business and industry to become increasingly aware that maintaining a competitive, commercial edge requires the careful consideration of energy efficiency.

Canada's industries established Energy Conservation Task Forces to look at potential improvements to applied technologies and the replacement of old equipment by new and more efficient and economic techniques. While these efforts proved to be very effective and successful, energy use and consumption in Canada still provides considerable potential for reductions, particularly in the area of waste heat recovery, including low temperature heat utilization.

In this context, a new A/CERRF subprogram, the Waste Heat Recovery/Low Temperature Heat Utilization Research, Development and Demonstration Program, has been developed during the past fiscal year in close cooperation with representatives from industry, academia and governments. The program is aimed at increasing awareness of and encouraging the demonstration and use of applicable new technologies and methods in Alberta's industrial and commercial sector. The focus is on cost-effectiveness under existing energy cost conditions and on the potential for wide introduction, application and commercialization of such waste heat recovery technologies in Alberta.

While no preference is given to any particular waste heat recovery technology, suggested project areas include applications of waste heat recovery in industrial, commercial and institutional facilities, waste heat recovery from compressors and process exhaust systems, waste heat recovery for agricultural applications, the application of heat pumps and encouragement of small-scale cogeneration.

A detailed terms of reference brochure has been produced and related project proposals were solicited through Alberta's major newspapers in March 1985. Following the usual procedure of review evaluation and selection of worthy proposals, approval and subsequent start-up of project work is expected by the fall of fiscal year 1985/86.

Summary of Program Expenditures Appendix A

A/CERRF Energy Conservation and Renewable Energy Projects and Expenditures to Date

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	Projected Future Funding 1985-86	Projected Total Funding Contribution
General Energy Conservation						
Control of Energy Losses by Microbial Fouling of Heat Exchangers	94 795	-	-	-	-	94 795
Ice Nucleation Technique for Defouling Heat Exchangers	75 459	3 799	-	-	-	79 258
Using Thermal Discharges from Power Plants	15 000	-	-	-	-	15 000
Fuel and Fertilizer Production from Dairy Manure	23 324	-	-	-	-	23 324
Efficient Use of Low Heating Value Fuels	59 677	143	-	-	-	59 820
Streamline Device for Transport Trucks	8 916	-	-	-	-	8 916
Energy from Waste Wood (Sawmill Residue)	114 501	-	-	-	-	114 501
Efficiency of Rotary Piston Engine	11 857	-	-	-	-	11 857
District Heating Study	93 400	-	-	-	-	93 400
Energy Conservation in Sour Gas Processing	918 574	34 963	93 637	131 399	-	1 178 573
Solar Energy						
Copper-Oxide Solar Cells	28 870	-	-	-	-	28 870
An Atlas of Solar Energy for Alberta	44 629	-	-	-	-	44 629
Application for Boiling and Condensation Heat Transfer for Flat Solar Collectors in Cold Regions	86 223	12 977	-	-	-	99 200
An Air-Mediated Solar Heating System with Long-Term Storage	42 613	-	-	-	-	42 613
An Advanced Control Approach for Solar Heating Systems	10 219	3 082	-	540	-	13 841
Geothermal Energy						
Research on Alberta's Geothermal Energy Resource	196 775	83 875	57 560	-	-	338 210
Fusion Energy						
Laser Fusion Energy Research	329 745	152 927	148 035	-	-	630 707

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	Projected Future Funding 1985-86	Projected Total Funding Contribution
Energy Conservation in Buildings						
Alberta Home Heating Research Facility	224 260	19 258	266	-	-	243 784
Insulation Properties of Flat Built-Up Roofs	47 957	7 980	-	-	-	55 937
Passive Solar-Heated Community Centre	12 170	2 000	-	-	-	14 170
Energy-Efficient Masonry Fireplaces	-	48 820	-	-	-	48 820
Edmonton Energy Conservation Centre	-	-	-	51 920	25 000	76 920
Self-Help Retrofit Manual for Owners of Multi-Family Housing Units	-	-	1 744	12 806	10 850	25 400
Retrofit Wall Systems for Residential Housing	-	-	342	2 540	6 998	9 880
Energy Savings and Payback of Retrofit Basement Wall Insulation	-	-	506	8 435	4 709	13 650
Energy-Efficient Housing Display Program	221 332	3 614	7 384	1 670	-	234 000
Townhouse Retrofit Demonstration	-	-	6 477	11 048	2 977	20 502
A Survey of Air Leakage in Alberta Homes	-	-	15 709	40 071	7 220	63 000
Construction and Testing of a Masonry Module	-	-	9 931	14 750	6 389	31 070
Concrete Masonry Walls for Thermal Storage, Heating and Insulation	-	-	5 861	10 440	-	16 301
Sizing of Warm Air Furnaces for Residential Use	-	-	3 192	127	-	3 319
Development of Higher-Efficiency Gas-Fired Furnaces	-	-	4 376	35 624	30 000	70 000
Seasonal Efficiency of Residential Natural Gas Furnaces	-	-	-	20 261	15 389	35 650
Development of an Insulating Curtain for Residential Installation	-	-	8 047	25 917	-	33 964
Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology	-	-	943	5 967	6 115	13 025
Energy Conservation in Public Swimming Pools	-	-	9 969	20 236	1 636	31 841
Development of a User-Friendly Computerized Building Management System	-	-	4 928	37 281	28 397	70 606
Multi-Zone Setback Thermostat	-	-	8 359	28 553	4 048	40 960
A New Heat-Conserving Control System for Warehouse-Type Buildings	-	-	3 538	17 782	10 360	31 680
Demonstration of a Cost-Effective Energy Management System	-	-	8 427	8 359	3 538	20 324
A Ventilation Control System Based on Carbon Dioxide Levels	-	-	604	750	-	1 354
Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta	-	-	1 484	35 681	-	37 165
Energy-Efficient Fluorescent Lighting Ballast	-	-	19 565	30 372	-	49 937
Computer Simulations for Mechanical Systems in Buildings	-	-	8 886	27 885	12 429	49 200
Wind Energy						
Comparison of Wind Turbines	10 686	14 310	-	-	-	24 996
Demonstration and Testing of Small-Scale Wind Turbines	-	72 386	47 324	34 408	62 000	216 118
Solar and Wind Energy Research	1 573 307	233 699	254 195	230 179	213 534	2 504 914
A Large Delta-Blade Wind Turbine, an Alberta Development	92 945	170 400	477 772	35 294	148 000	924 411
TOTAL - Energy Conservation and Renewable Energy Projects	**4 337 234**	**864 233**	**1 209 061**	**880 295**	**599 589**	**7 890 412**

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